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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

FEBRUARY 5, 1990

RESTRUCTURING EDA

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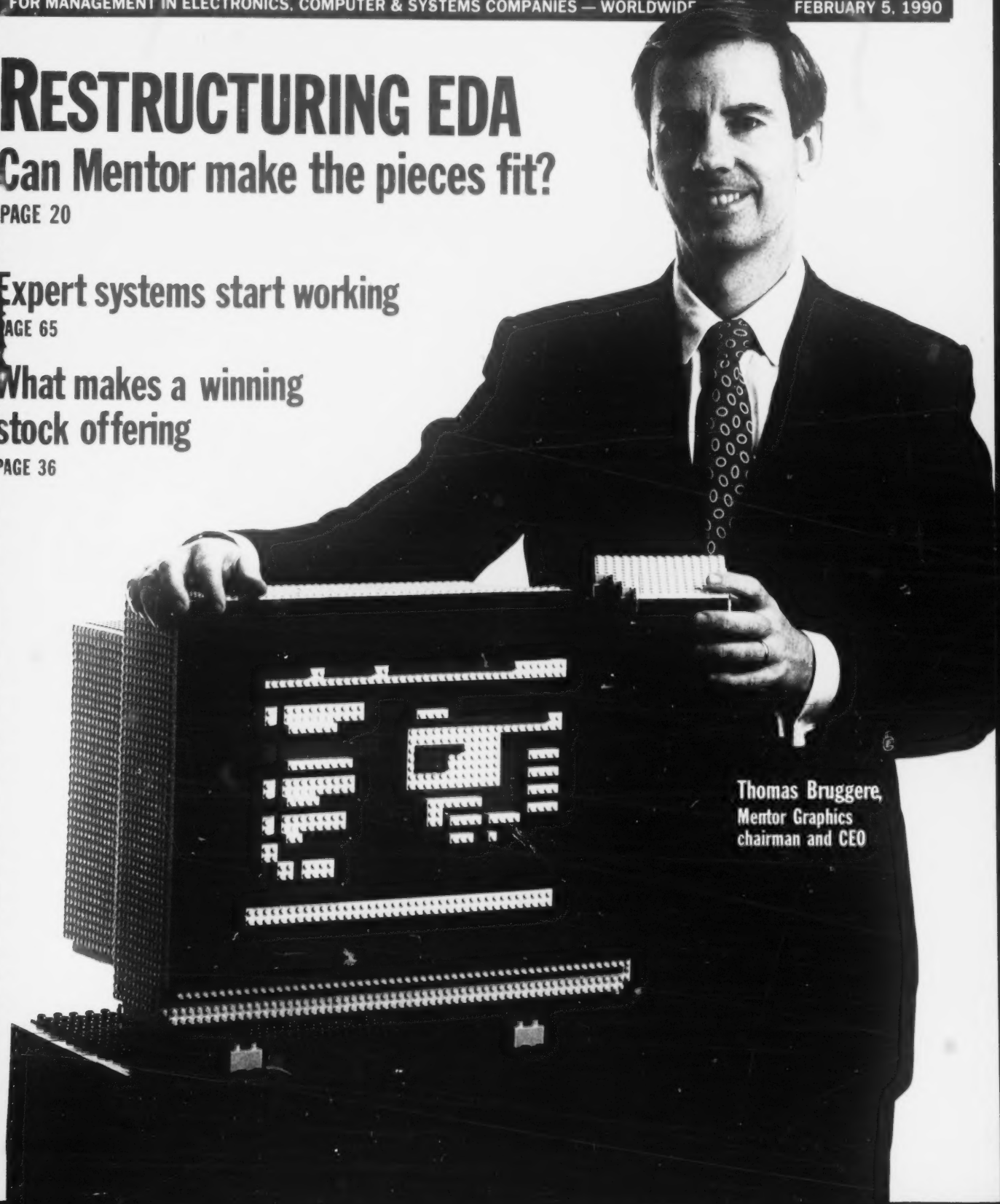

Thomas Bruggere, Mentor Graphics chairman and CEO

Electronic Business

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VOL. 16, NO. 3

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Cover photograph: Kristin Finnegan

COVER STORY/STRATEGIES

20 Mentor Graphics wants to rebuild the design industry

Nine years ago, Thomas Bruggere had an idea that would change the way design engineers do their work. He and eight cofounders turned that idea into Mentor Graphics, a company that became the leading player in the electronic design automation market. But now Mentor is on the verge of tearing down the EDA structure it built and starting all over again. Why? Because the company is at a crossroads and executives must reconsider some of the basic decisions they made when the company was first formed.

BUSINESS TRENDS

15 DOD wants to throw tons of paperwork overboard

The Defense Dept.'s digital documentation standard, CALS, has blossomed into a broad initiative with ramifications well beyond the DOD and its contractors. Computer-industry suppliers are scrambling to build systems that comply and some predict that CALS-defined standards will radiate throughout their commercial product lines.

STRATEGIES

20 Mentor Graphics wants to rebuild the design industry

After surviving fierce struggles in the early and mid-1980s, Mentor Graphics is once again on the firing line. Why? Because the company is at a crossroads and executives must reconsider some of the basic decisions they made when the company was first formed. And Mentor is being challenged by new, hungry and technically competent competitors.

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This machine vision vendor is thriving in a shaky industry by convincing OEMs it makes a better product than they themselves can. Cognex's pitch is that these companies should be spending their hard-earned R&D dollars and energy on solving their application problems, not trying to develop their own machine vision products. Sales growth is proof that CEO Robert Shillman's strategy is right.

32 Management leadership is key to Zilog's turnaround

As proof of their commitment to Zilog's nascent turnaround, Zilog's management and employees put up a reported $35 million to buy the company outright from Exxon. To make the buy-out work, Zilog president Ed Sack is counting on a traditional management style, cost cutting and a leading-edge product strategy.

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Today's market for initial public stock offerings can double the share price of a well-received company within a few months. Yet stocks that fail to meet the increasingly rigorous standards of IPO investors may fare badly. The result is that both huge gains and huge losses are found in the after-market performance of electronics ventures that went public in 1989.

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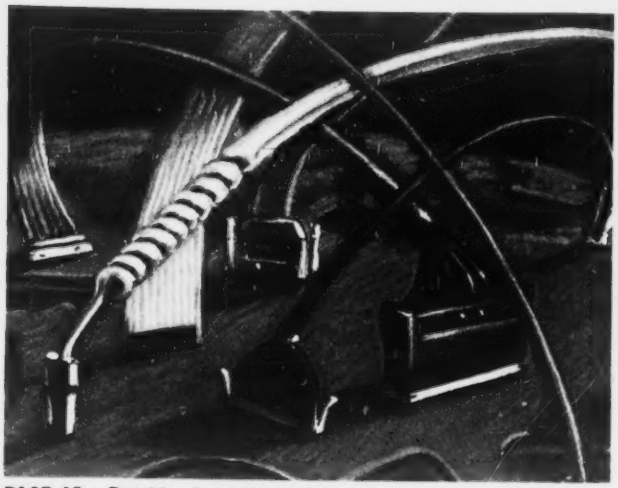

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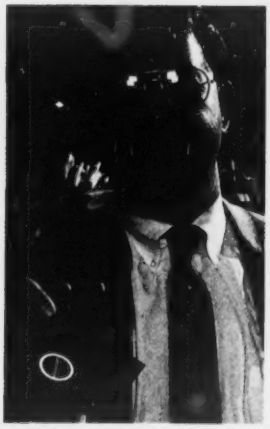

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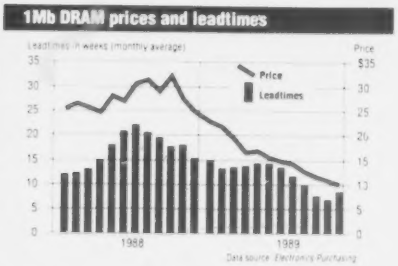

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55 U.S. electronics firms in China: Returning to normal?

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MARKET PERSPECTIVES

60 Who rules the low-end page printer market? HP

In low-end page printer territory, Hewlett-Packard is king. Having gotten a jump on that market a few years back, the large Palo Alto, California-based computer maker continues to beat out its competition by taking the industry to new lows — a little lower performance for a much lower price. But with IBM and Xerox as competitors, how long can HP stay king of the slow and the small?

65 Artificial intelligence finds work in manufacturing

After years of trying, expert systems suppliers are finally finding their way into the hearts and budgets of a wide variety of manufacturers. As the hype surrounding these artificial intelligence-based decision-making aids subsides, competitors are scrambling to provide solutions to nuts and bolts production problems — and manufacturers are discovering thousands of applications.

73 Board makers hedge their bets in EISA-MCA Bus Wars

Can the industry support two microprocessor bus standards? Board manufacturers think so; they're finally designing add-ons that support either architecture. Yet as more board makers commit to the EISA bus, all are questioning how fast and how far the market will grow.

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Turning tide in EDA

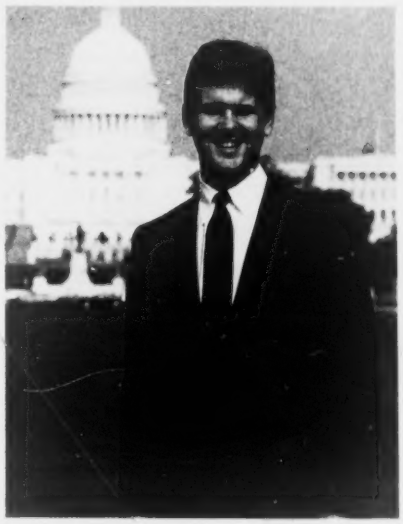
The story of Mentor Graphics' evolution to becoming the leader in the electronic design automation industry is not without an interesting, and ironic, twist. In the early and mid-1980s when the character of the fast-growing EDA field was being shaped, Mentor's chairman and cofounder Thomas Bruggere made the decision to align his company's tools with a nonproprietary hardware platform, Apollo workstations. Competitors sat still, stayed with proprietary platforms and then stumbled.

Now, despite the success that's allowed it to carve out a 12% chunk of the $3 billion EDA market, Mentor, it seems, has been the one sitting on a proprietary platform. Fate wouldn't have it any other way.

Associate editor Tony Greene wrote our cover story and examines some critical decisions Mentor will have to make if it is to keep its lead in the industry. Suddenly, a perception of openness and platform independence is pervasive in EDA and hungry competitors such as Cadence and Valid Logic are hot on Mentor's tail with their new open systems. So what has Mentor done to counteract this predicament? Earlier this year it added a second platform, the Sun Microsystems workstation.

Mentor president Gerry Langeler acknowledges that the company is setting itself up for a "gradual shift" toward a more open design environment. A key question remains, though: Will Mentor go beyond porting a second platform?

At this summer's Design Automation Conference Mentor plans to unveil its next generation of software, Release 8.0, that Langeler promises will guide the platform decision. With Mentor at a crossroads, 1990 certainly promises to be a year worth watching in the EDA industry.



Associate editor Tony Greene, Washington bureau

Although Tony Greene traveled to Beaverton, Ore., to report his Mentor story, don't be fooled by our photograph of him with that historic building in the background. Since last fall Tony has been our Washington, D.C., bureau editor. While he still manages to sneak in a story on a Mentor or Hewlett-Packard, he has been spending most of his time sizing up U.S. senators, Bush administration officials, lobbyists and the government issues likely to affect electronics.

A promotion left us without a full-time staffer in Washington for more than a year. But with electronics emerging to the forefront of U.S. competitiveness issues it was certainly time for ELECTRONIC BUSINESS to be in the Capitol again. Feel free to give Tony a call in Washington. (202-628-2773).

MARVIN GREENE, section editor

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VBPA ABP

Selling to the competition pays handsomely for Cognex

This machine vision vendor is thriving in a shaky industry by convincing OEMs it makes a better product than they can themselves. Sales growth is the proof

BY ROSE MULA

It must be nice when some of the world's largest users of the product your company manufactures stop making it themselves and turn to you instead. That's the way it has been for Cognex Corp., a Needham, Mass., maker of machine vision systems. The company's greatest source of competition is also its most promising growth area.

Original equipment manufacturers who build their own machine vision systems made up about half the $196 million market in 1988, Cognex says. The company's pitch is that these companies should be spending their hard-earned R&D dollars and energy on solving their application problems, not trying to develop their own machine vision products.

Cognex, which specializes in supplying systems to the electronics and semiconductor industries, insists it is more cost effective for original equipment manufacturers (OEMs) to buy machine vision from a second source. "We call them our 'captive customers,' " says Robert J. Shillman, chairman, president and CEO, "because we'll get them eventually."

When Shillman founded the company in 1981, Cognex targeted customers with customized turnkey operations, a profitless and time-consuming strategy, he admits. Those were the days when half-cocked prognostications hailed a billion-dollar market by 1990, and more than 100 companies sought to get in on the action. Operating continuously in the red was reason enough for the company to switch tactics and pursue OEM business.

The OEMs in Cognex's target group manufacture and market to end users automation equipment, such as wafer probers, which rely on an internal vision system to automatically align each semiconductor wafer prior to testing. The company's most significant convert is Shinkaa Ltd. of Japan, which signed a $9 million contract with Cognex in March 1989 — the largest in the history of the vision industry. Last September, Cognex entered into what it calls a multimillion dollar alliance with Komatsu Ltd. of Japan, a manufacturer of construction and industrial equipment, to supply vision products.

Robert J. Shillman, chairman, president and CEO: Seeking to attract the "captives"

Claims 10% to 20% share

Cognex claims a 10% to 20% share of the half of the market not controlled by the "captives" who build their own systems. That is a substantially larger share than any of its competitors have, Shillman says. Nearly 75% of the total market is concentrated in the electronics and automotive arenas, according to Bader Associates.

Cognex competes directly with other machine vision companies, such as ICOS, Intelledex Inc., View Engineering Inc., International Robomation Intelligence (IRI) and Adept Technology Inc.

Cognex had nine-month revenue, ending Oct. 1, 1989, of $11.2 million; net income for the same period was $2.58 million. For all of fiscal 1988 the company's revenue was $10.6 million, with net income of $2.37 million. "Except for the 'captives,' " Shillman says, "we really are the market leader in the country and maybe the world. It's still a small business, but we're growing nicely." Cognex's success allowed it to go public last July with an initial public offering price of $11. As of late last year the stock had

closed at $16.

Richard D. Schwarz, first vice president at Shearson Lehman Hutton Inc., who follows the machine vision industry, testifies to the vigor of Cognex. "It's a very tough business," he says, "which makes the current margins at Cognex all the more outstanding." Many of the companies that first jumped on the machine vision bandwagon in the early days have fallen by the wayside, Schwarz notes.

One of the factors contributing to the company's growth is the decision to develop standard products — proprietary vision software and a vision engine, which sophisticated OEMs and systems integrators can use as tools or building blocks. The advantage to Cognex is that its products require minimal customization and support. The advantage to customers is that they don't need an extensive understanding of image processing to configure Cognex's products into complete vision solutions for their own customers.

Powerful, flexible systems

In addition to the OEMs in Cognex's target group, other OEM equipment currently using Cognex vision systems include laser memory repair systems, wafer dicers, die bonders, wire bonders, package printers for integrated circuits, printing systems for the production of printed circuit boards, and placement equipment for loading circuits onto printed circuit boards. Vision systems for these applications must be powerful and highly programmable in order to give OEM design engineers flexibility in integrating the system into their products.

Cognex fills its customers' needs with its proprietary software and a family of proprietary machine vision engines. The least expensive, the Cognex 1500 is an application-specific, total-solution, menu-driven system that requires no computer programming. This is not contradictory to the company's new strategy of disengaging itself from small, specific-solution applications.

Customers don't need an extensive understanding of image processing to configure Cognex's products

"Now we get involved only in applications that have leverage —where the solution is applicable to a number of situations — from counting the number of chocolate chips in a cookie to the number of pills in a bottle, for example," Shillman explains. More important, he adds, when Cognex was selling to end users, the deals were often one-shot sales that required a lot of engineering support. Selling to OEMs is much easier. "We sell the solution once to the OEM," he says. "Every time it resells that solution, a Cognex vision system is part of the package, and no additional support is required from us."

For more sophisticated applications, Cognex offers its 2000 and 3000 series. Because both the software and hardware components of the system are compatible, customers can start with the 2000 and easily upgrade it as their performance requirement increases.

Future strategy

The company's strategy for the future includes the development of a family of simplified systems that will dramatically broaden its market to encompass a wide range of unsophisticated users.

"Right now, to use our 2000/3000 series, an engineer doesn't have to know vision but does have to be a good computer programmer," Shillman says. "Our next layer of products will remove that requirement." In the past other companies have tried to sell easy-to-use, low-cost systems, but they lacked one element, he says — powerful vision.

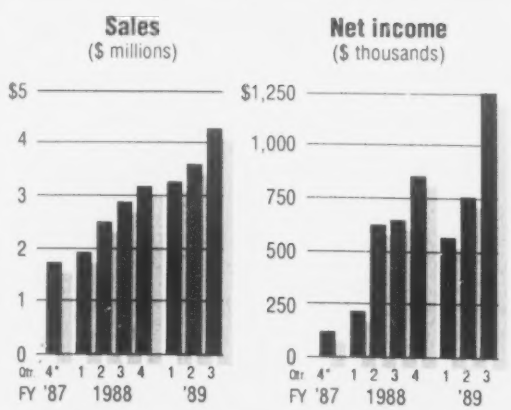
"The technology wasn't there," he says. "We've proven that our technology can do the job." This isn't pie in the sky, he claims. Cognex engineers are already designing such a

Cognex at a glance

	1988	1987	Change
Sales ($ thousands)	$10,630	$6,319	+68.2%
Net income ($ thousands)	$2,376	$258	+820.9%
Net income/ sales	22.4%	4.1%	—
Cost of sales/sales	24.5%	30.3%	—
R&D/sales	17.6%	19.7%	—
Marketing, G&A/sales	35.0%	47.4%	—
Number of employees	81	NA	NA
Sales per employee	$131,235	NA	NA
Net income per employee	$29,333	NA	NA
Capital expenditures/sales	2.4%	3.9%	—
Current ratio	2.59	2.63	—
Debt/equity ratio	0.04	0.10	—
Foreign sales/sales	21.3%	12.0%	—

All figures for fiscal year ending December 31,

Quarterly results



* Unaudited

Source: Company reports

simplified product, and the company hopes to announce it within a year. These systems will finally make machine vision practical for the hundreds of thousands of companies that need it, Shillman believes.

"The early projections weren't that far off base," he says. "There really is a billion-dollar market out there." But Eric Keller, an industry analyst with the Gartner Group, is skeptical about such predictions.

While conceding that Cognex has put together a business strategy that has allowed it to make money in an otherwise shaky industry, Keller believes a billion-dollar market is as unrealistic today as it was in the industry's infancy. "Everybody, no matter how tiny their business, is convinced it has billion-dollar potential," Keller says. "If Cognex can pop out really simplified systems like [appliance manufacturers turn out] toasters, then, sure, it could become the Lotus 1-2-3 of the machine vision industry." Keller recommends that Cognex stick to the original strategy that saved it — providing sophisticated systems to OEMs — instead of trying to become all things to all people. "It won't make a billion," he says, "but it can survive and remain profitable."

The vision market is growing, Keller says, but extremely slowly — only 4% last year, according to The American Vision Association in Ann Arbor, Mich.

A Frost & Sullivan report is more optimistic about the market. Although the explosive growth predicted for machine vision in the early '80s has not yet materialized, F&S analysts believe that today, after several years' experience, the reasons for optimism are still valid.

Looking ahead, Frost & Sullivan projects dollar sales of $668 million by 1994 in three major markets: electronics, automotive, and microelectronics/semiconductors. Further, both the electronics and semiconductor industries, Cognex's major market areas in which machine vision is becoming well established, will weather any recession and achieve solid growth over the next several years, the report's authors project.

Cognex's strategy for the future includes simplified systems for unsophisticated users

Raj Rajarantnam, an analyst with Needham & Co. Inc., one of the underwriters of Cognex's IPO, is equally — if not more — optimistic. Cognex's future growth prospects are excellent, he says. The reason the machine vision industry did not develop as fast as predicted in the mid-'80s, he says, is simply that vendors did not do a good job of solving customer problems. "Today Cognex is doing exactly that — and doing it better than any of the other players — and that should pay off big for the company," Rajarantnam adds.

An executive at General Signal's Electroglas division in Santa Clara, Calif., a major Cognex customer, echoes that sentiment. "Our prior vendor wasn't meeting our requirements," president William Cornwell says. "Cognex kept coming back to us to try to gain a real understanding of our needs, and eventually it came up with a solution for us. Naturally, we switched."

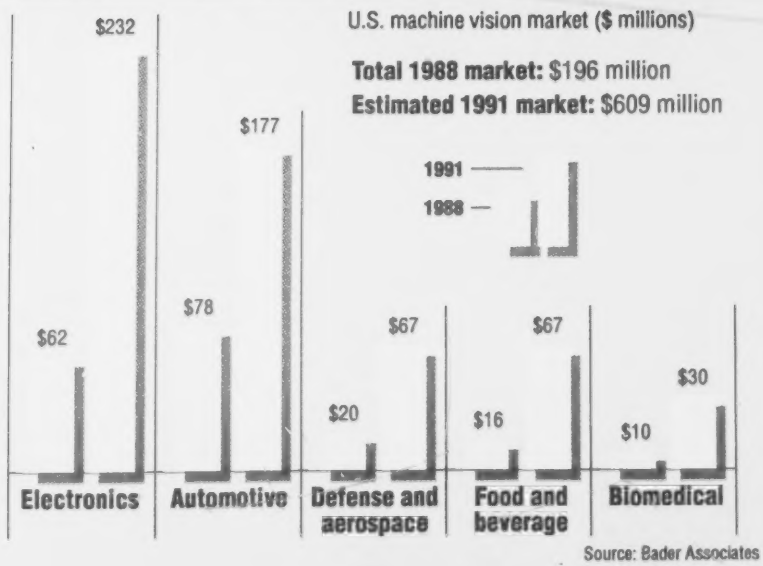
But Cognex can't rest on such lofty praise, says Jeff O'Dell, manager of sales for Microvision, a Minneapolis-based systems integrator and Cognex customer. "Right now it's one of the leaders in the technology of machine vision," he says. "Its level of technical sophistication is tops, and its price/performance excellent." However, he adds, as a systems integrator, his company is obligated to survey the market constantly. "Cognex has a good head start, but some other companies — especially Adept and Intelledex — are coming along quite impressively," he says.

Cognex will have no problem staying competitive, Shillman claims. "Our products typically have a much higher price/performance ratio, perhaps by a factor of two, than those of our competitors," he says. But if so, why isn't the company's market share even larger than it is?

When the company changed its strategy to target OEMs, Shillman says, it didn't have a large enough sales force to attack in Europe and Japan — "so some of our competitors were able to get a foot in the door. That's a big plus in this industry."

But many of his competitors' customers have indicated they will switch to Cognex in their next generation of products, Shillman claims. Only time will tell, of course, but one thing is certain: Cognex has a track record of devising strategies that have enabled it to adapt to changing industry conditions and not only survive, but thrive. □

Growth markets in machine vision



Source: Bader Associates

Management leadership is key to Zilog's turnaround

To make a $35 million buy-out from Exxon work, Zilog president Ed Sack is counting on a traditional management style, cost cutting and a leading-edge product strategy

BY TOM QUINLAN

By 1984 Zilog Inc. had become a moribund company. It was relying on 7-year-old technology and was burdened by revolving-door management and financial losses — which were $30 million a year at the time, some former employees report.

Backed by the resources of mammoth owner Exxon Corp., Zilog claimed a sizable market share for its flagship product, the Z80 8-bit microprocessor. According to market researcher Dataquest Inc., the Campbell, Calif., company's unit share of the 8-bit market worldwide was 36.4% in 1984. But Zilog also had a stack of incomplete design projects, a reputation for missed market opportunities and the atmosphere of a club for retired semiconductor engineers.

Since then, however, the privately held company has cut costs, strengthened its core business and is moving aggressively into the application-specific integrated circuit (ASIC) market. As proof of their commitment to Zilog's nascent turnaround, president Ed Sack, his management team and other employees, along with the venture capital firm E.M. Warburg, Pincus Capital Co., put up a reported $35 million to buy the company outright from Exxon.

The buyers apparently got a bargain basement price. Sources close to the negotiations say it was only about half as much as Exxon was asking. For their money, they got a company with a 20% annual growth rate. Zilog's 1988 revenue is estimated at $90 million, according to Dataquest.

Strong management

Profitability, continued demand for Zilog products, low prices and high-quality production were all factors in his company's decision to invest in the buy-back, says William Janeway, a Warburg, Pincus managing director. But top-drawer management was the deciding factor, he adds. "We look for strong management at the companies we invest in," Janeway says, "and Zilog's management is excellent."

And customers, despite the aging 8-bit product line, continue to speak highly of Zilog and its management. Allen-Bradley Co. Inc., a division of Rockwell International Corp., continues to rely on Zilog components for a third of its products, even as it buys from the 8-bit and 16-bit lines of Intel Corp. and Motorola Inc.

Zilog's third major selling point, after quality and on-time delivery, is a management team he can trust, says Dwight Smith, electronics group purchasing supervisor at Allen-Bradley.

"You'd better believe we keep a close eye on that," Smith says. "We have an interest in making sure a company is going to be around, and management is a big part of that."

Liane Enkelis

Zilog president Ed Sack: Mission was to restore the confidence of both customers and employees in the company

Back to basics

Restoring the confidence of both customers and employees has been Sack's mission since Exxon hired him away from General Instrument Corp. in November 1984 to head Zilog. Sack recalls riding the Long Island Railroad to his General Instrument job in Hicksville, N.Y., and overhearing commuting financial analysts complain there wasn't a single Silicon Valley semiconductor company they could trust.

"Not one was being run following general principles of business," Sack says, "and I was sure I could run one like a business."

Although Sack holds a doctorate in electrical engineering from Carnegie-Mellon University in Pittsburgh and has been awarded 15 patents, management rather than technical issues have absorbed most of his time at Zilog. He judges his success largely by his ability to introduce traditional management techniques in place of what he calls "the typical Silicon Valley approach," which he discovered on his arrival at Zilog.

Even though the company was dependent on the business from its Z80 and related products, Sack says he found more attention being paid to designing products for new markets instead of ensuring quality for the existing line. "There's no other industry in the world that could get away with the production yields that are considered satisfactory in the semiconductor industry," he complains.

"When I first came here, they had people in the communications department dedicated to drawing Captain Zilog's shoe," Sack recalls, referring to the cartoon character used to promote the company's products.

Even worse, Sack says, was the number of ongoing design projects that showed no chance of ever being completed. The first step, as he saw it, was to tighten the work force, which he reduced by about half. The second step was to reestablish the company's reputation as a quality supplier.

That meant protecting and strengthening Zilog's core business of selling 8-bit products and dropping attempts to loosen the Intel-Motorola stranglehold on microprocessor markets. The idea, Sack says, was to stop competing head-on with Intel and Motorola and their dominant microprocessor products.

Focus on quality

Much of Zilog's success over recent years can be attributed to the company's focus on quality and efficient production, says Alice Leeper, senior industry analyst for Dataquest Inc. "Customers know they're going to get a product that meets their needs, they're going to get it on time, and the quality will be good," she says.

Zilog has an advantage over its competitors, because it has been manufacturing its 8-bit product for such a long time, Leeper adds. "There aren't any surprises in building this product line, and Zilog can control manufacturing costs with the best of them," she says. "They aren't going to be underpriced."

Yet Zilog's manufacturing dependability doesn't impress Michael Feibus, an analyst for market research firm In-Stat Inc. "To tell you the truth, I don't really follow Zilog. They're not exactly on the cutting edge of technology."

On his arrival at Zilog in 1984, Sack found "the typical Silicon Valley approach"

In fact, while Zilog claims it has returned to profitability and has boosted its unit share of the 8-bit market to 42.6% in 1988, according to Dataquest, it may be in the position of building clipper ships while everyone else is building steamships. As much as half of the company's revenue is dependent on mature product lines that were established before Sack took over the company's presidency, a situation that pleases no one at Zilog, admits Wayne Ricciardi, Zilog's vice president of marketing and sales. "We realize that, while the Z80 might last another 10 years, technology has a definite life span, just like anything else," he says.

Although the company has had measurable success with the Z16C36 Universal Serial Controller, introduced in January 1989, Zilog is ready to make more of a splash now. It introduced some 15 new products last year, including its first move into the ASIC arena.

Next test for management

The true test both of Zilog's ability to market new designs and of its management strength will be the success of superintegration, the name it gives to its modified ASIC design methodology.

While Zilog will not design ASIC components as such, the company intends to design arrays of standard components for use by computer peripheral manufacturers.

"Peripheral manufacturers can tell us what they need, and we'll put it all together for them," Sack says. "This way, they don't have to worry about uneven component quality."

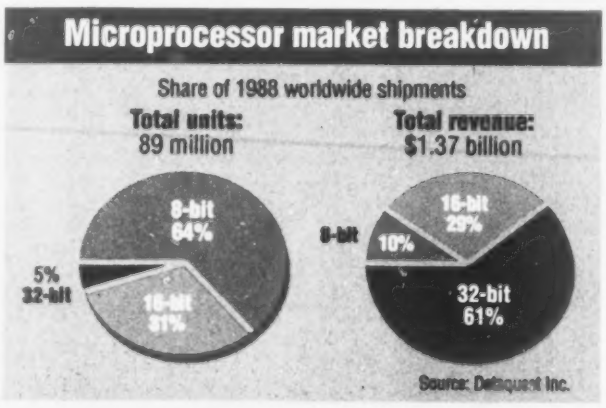
Superintegration could force Zilog into capital spending and require more money from Warburg, Pincus. However, Zilog might be able to fund any necessary expansion on its own, says William Walker, Zilog senior vice president of finance and administration and a member of Zilog's management committee. "We've had a positive cash flow for the last couple of years."

Such a move poses a new kind of challenge to a management team that has been dedicated to cutting cost and improving production quality.

The current management has been credited with the successes of the past four years, but not without generating criticisms of Sack's personal management style, which has been described as abrasive and volatile by former Zilog employees.

Some who have worked closely with Sack say they have doubts about his ability to fit his management style to the new needs of a Zilog determined to expand.

Sack himself, however, has no such doubts. "I tend to do whatever job the company needs me to do." □



Zilog's strength is its 42.6% share of unit shipments of 8-bit microprocessors. Its greatest test will be moving into less mature but more profitable markets

Patching in to Europe's connector markets for 1992

Expecting mixed regional demand in post-1992 Europe, connector makers are going for growth wherever they can find it

BY BARBARA N. BERKMAN

In the United States, connector makers are just about reconciled to the adverse conditions of their business: the routine price erosion, vendor reductions and consolidation of major players in a crowded market. But connector makers in Europe have an even bigger concern: servicing customers on a pan-European basis in a market that by nature demands a patchwork of local marketing strategies.

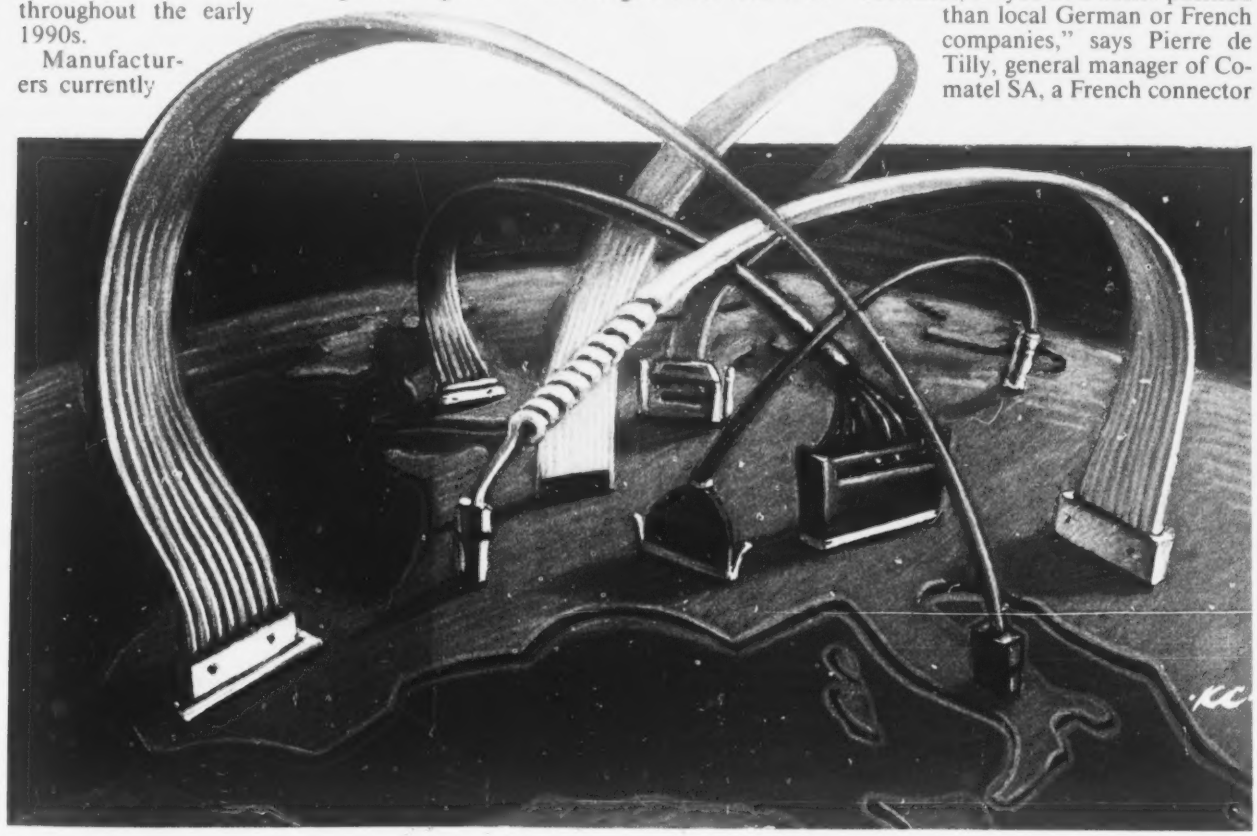
Overall growth makes the European market an attractive one, but the challenge connector makers face is to find profitable niches in those countries that will see flat growth throughout the early 1990s.

Manufacturers currently are mobilizing to take their places in the unification of the European market by shoring up production capacity, adding marketing staff in countries with steady growth, changing distribution channels or countering the flat military market.

The European market was worth $2.48 billion in 1988 and is predicted to grow 4.1% annually to an estimated $2.92 billion by 1992, according to research by Elsevier Advanced Technology in Oxford, England. The most robust market is Italy, where growth will average 5% between 1988 and 1992, Elsevier estimates. By 1992 Italy's share of the connector market will be an estimated 7.8%.

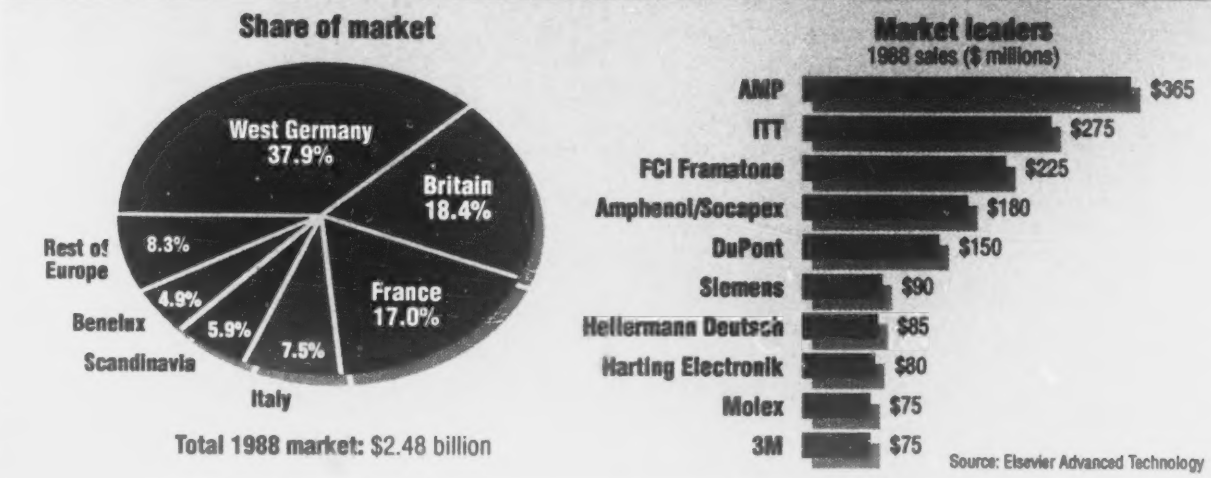
Despite such steady growth, Italy's market, amounting to $227 million in 1992, won't come near the estimated $1.1 billion market projected to exist in West Germany by 1992. West Germany will represent a 38% share of the total European connector market early in the next decade.

For U.S. firms with a longtime European presence, marketing and manufacturing with a local flavor is a lesson already learned. "Americans are already ahead of the European countries, maybe in a better position than local German or French companies," says Pierre de Tilly, general manager of Comatel SA, a French connector



Ken Condon

European connector market



division of Unitech plc of Reading, England.

AMP Inc. of Harrisburg, Pa., for example, has three production facilities in West Germany alone, and six elsewhere in Europe. Molex Inc., headquartered in Chicago, has five European plants.

The largest European connector supplier is AMP, followed by ITT Electromechanical Components Corp. of Fountain Valley, Calif., which operates the Sealectro and Cannon groups. In 1989 the French holding company FCI Framatone Connectors International catapulted to third place with recent acquisitions of Souriau et Cie, the smaller French company Constructions Electriques Jupiter, and Burndy Corp. in Norwalk, Conn.

Connector makers large and small are picking their way through the spotty patches of growth in Europe. Severe price competition remains in Britain and Germany, where price erosion will limit growth in dollar value terms to around 4%, although actual volume growth will increase beyond 10%, Elsevier predicts.

"Driving the [British] market is the optimistic automotive market. Telecommunications is fairly flat, but will hopefully improve with ISDN [Integrated Services Digital Network], as more countries latch on to integrated networks," notes Neville Lyons, a director of Britain's Electronic Components Industry Federation.

Just behind Britain and West Germany is France, where the market is predicted to grow at a 3.9% annual rate for 1988 through 1992. Slowed deregulation of the French telecommunications industry resulted in a currently flat market for connector makers. "There's not a strong telecommunications market in France. Many [telecom end] products in France never came to be, so there is no high volume," says André Boulay, a product manager with Thomas & Betts France.

Flooded market

The market for fiber-optic connectors will reach $136 million by 1992, Elsevier projects. The fastest growing fiber optics connector application was once telecommunications, a market fueled by the PTTs, Europe's state-controlled public telephone companies, which installed fiber-optic networks throughout the mid-1980s. At present, connectors serving the data communications industry are the fast-growth products. Elsevier predicts a 24% annual growth rate in fiber-optic connectors for data applications throughout Europe.

The market for insulation displacement contact (IDC) connectors, particularly for peripheral and computer interface applications, is flooded with suppliers from within Europe and from the Far East. Elsevier estimates annual growth for IDC connectors at 2.8% annually to 1992 in Europe. "There is going to be price pressure," predicts Lindsay Powell, a marketing executive of IDC market leader 3M Co., who is based in Bracknell, England. In response, the larger connector companies are increasing their service ties to their big accounts. "We're getting business clearly on service," Powell says.

Because of overall decreased defense spending in Europe, military connector suppliers face a rough ride ahead. For example, AB Connectors Ltd. in Abercynon, Wales — like other connector divisions heavily dependent on military sales in their home markets — just started "de-engineering" its military products for industrial use, sales director Robert Trevor Jenkins reports.

The shift isn't easy. Although AB is among the top 20 European connector suppliers, 90% of its sales are inside Britain, and it is just learning about local marketing strategies outside the country. Marketing and engineering employees familiar with selling and designing industrial products are hard to come by in that coal-mining part of England, Jenkins says. "But this is the home of AB Connectors, and until we develop an export market, [home] it will remain."

Other military connector suppliers are feeling the crunch as well. Bowthorpe Holdings plc has a European connector market share of roughly 5%, but its Hellermann Deutsch Ltd. subsidiary operates a military sales division. Unlike AB, Hellermann's strategy is to continue as a military specialist, working more closely on design development as a marketing strategy. If products are designed into end products, Heller-

A British call for customer service

As practiced in England, customer service is about as common as a cloudless day. But vendor reduction programs have forced the connector industry to take more than a fleeting glance at the concept of customer service.

"Prices we can negotiate. All the connector makers operate at something like 90% quality. But the majority are about 50% to 60% efficient on delivery," notes Joe Fairclough, purchasing manager of the Dynamics division of British Aerospace plc.

"The only way to get to grips with all these problems is to reduce the supplier base," he adds. Of course, the road goes two ways. Fairclough admits that "some of the delivery problems might be related to our own operations." The problem is one of lack of communication between customer and vendor. The result is that British Aerospace has placed orders without getting updated information on delivery leadtimes.

Yet a study by a British joint government and industry research group warned that most British component firms are lax in delivering the level of customer service acceptable to keep customers' business. Failure to return phone calls, respond to customers or embrace modern-day technology for taking orders was adversely affecting purchasing decisions, the report said.

Component firms typically had only ad hoc training programs in customer service, according to the Electronic Components and Technology Sector Group of the National Economic Development Council. As a result, mislabeling led to parts being shipped in unrecognizable packages.

Despite being in the technology business themselves, too few components makers seemed aware of fax machines or electronic data as preferred means to the telephone in taking orders.

That doesn't bode well for suppliers who don't use the latest technology for exchanging orders and invoices, Electronic Data Interchange. EDI automatically transmits order information and therefore cuts many delays. Only 28% of potential European users of EDI were aware it existed, according to a recent study by BIS Mackintosh Ltd.

Yet more OEMs are asking EDI capability from their suppliers. International Computer Ltd. (ICL), the British computer company subsidiary of STC plc, has 40 vendors on the system. "We've gone absolutely to the side of transmitting automatically and we'd like to do it with all our components suppliers," warns Sadru Nanji, manager of components purchasing at ICL's components products center. Since ICL has targeted a 10% annual reduction in vendors, those who don't use EDI aren't likely to remain suppliers for long. □

mann management reasons, the company can insulate itself from pan-European defense cuts. "We're targeting our customers more carefully and increasing the level of support," says Mike Walling, export manager in East Grinstead, England. "The market is stagnant, but we know who our customers will be."

In Europe, connector makers must learn to bend to the vagaries of local markets. Cinch Connectors Ltd. of Elk Grove, Ill., for example, recently has offered consignment stocking in response to sporadic requests, a way of appeasing customers outside England and Scotland who were worried about potential shipping delays from the island. "When there's a bit of water between us, and they worry about transportation, they feel comfortable with consignment stock," says Tony Knights, sales and marketing manager in Worksop, England. A subsidiary of Precision Mecanique Labinal, Cinch does about $15 million in European sales.

Augat Inc., headquartered in Mansfield, Mass., is chasing the Italian market by upgrading its Milan sales office to inventory-carrying status, doubling staff and investing almost $1 million. "Three years ago we were looking at a couple of thousand dollars in business [in Italy]," says Richard Wood, vice president for Europe. "It's $4 million now."

Augat is set to increase European sales beyond the current $25 million. It is investing $4 million in a facility in Telford, England, and European acquisitions are likely. Augat also invested $1.2 million in a new MIS system to provide instant data on customers. The investment is one of several to make Augat what Wood calls "a European company."

Niche strategies

Most connector makers are exploring niche strategies, finding opportunities even in stagnating or flat markets. Cinch is projecting 20% growth in connector sales to U.S. computer makers with subcontractors in Britain. With products that require multinational approvals, "we're gaining market share in a market that's not growing," Knights says.

Molex's European niche is in selling to the Japanese. "We see Japanese companies here, where we have excellent introductions," says Rein de Vries, director of European marketing in Munich. "We're focusing on Japanese companies that are coming here." With 40% of global sales fueled by consumer electronics and with strong manufacturing and marketing ties to Japan, Molex is pushing low-cost consumer connector products with uses in car radios or television equipment.

There are other niches for U.S. companies to explore. U.S. technology for telephone jacks is in demand in Europe, with the coming standardization of digital network systems. Molex is the largest manufacturer of telephone jacks and plugs in Europe, with "the competition coming from AMP, which is trying to keep market share by price fights," according to de Vries. There is room for niches for smaller players: Over the past two years Augat sold $10 million of modular frame connectors to British Telecommunications plc.

For European connector makers, 1990 will be marked by familiar obstacles. But by making their way through the maze of local marketing strategies, most connector makers in Europe have found niches that remain profitable. □

Software producers do battle over proposed EC directive

An attempt to strengthen legal protection for computer programs in the EC has turned into a fight between large and small manufacturers over how far the new rules should go

BY LINDA BERNIER

A proposed European Community directive that computer industry experts say will play a key role in the future development of the global software market has the world's leading computer companies embroiled in a fierce competitive battle. The directive, proposed last spring by the EC's legislative body, the European Commission, is designed to provide legal protection to computer programs within the community. A decision on the proposal is due this spring by the EC Council of Ministers.

The directive, which would harmonize and strengthen software protection throughout the EC, is part of the EC's effort to create a single market by 1992. Currently, national laws designed to protect computer programs from piracy vary widely throughout the EC, impeding the development of a pan-European software industry. The proposal would grant software copyright protection as literary works in accordance with generally accepted international standards.

"What will happen in Europe will determine what will happen worldwide in software protection," says IBM's Timothy Hollins, responsible for assessing EC policy and presenting the company's position to the myriad of EC officials influencing the EC decision-making process.

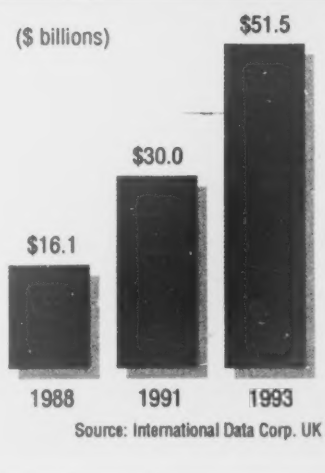
Two major issues lie at the core of the battle, which is being waged by powerful software producers such as IBM, Digital Equipment Corp., Microsoft Corp. and Lotus Development Corp. on one side; and so-called minor software vendors such as France's Groupe Bull, Italy's Ing. C. Olivetti & Co., Japan's Fujitsu Ltd. and U.S.-based NCR Corp. and Unysis Corp. on the other.

The first issue involves the extent to which interface specifications should be protected by copyright law. The second is whether some degree of reverse engineering, or the ability to get to a computer program's source code, should be specifically allowed in the directive.

Fear on both sides

While most computer software makers accept the general principles of the proposed directive, the minor software manufacturers fear it would favor the dominant, mostly American software makers and limit the development of a competitive European software industry. Conversely, the larger companies fear certain draft proposals and amendments would weaken current copyright law in Europe and, therefore, eventually in the United States and Japan. This would make it more difficult to combat software piracy and would ultimately jeopardize the boom in the world software market, which is growing at more than 20% annually.

High stakes in the European packaged software market



Source: International Data Corp. UK Ltd.

The big software producers have been fighting to drop a draft proposal that specifically would exclude interface specifications from copyright protection, insofar as these specifications contain none of the program's underlying ideas and principles.

These companies believe that such a proposal is unnecessary and confusing because existing copyright law excludes ideas and principles from protection. Mentioning the exclusion specifically for protection, they say, would weaken their control over those parts of interface software they claim are copyrightable. They say it shifts the burden of proving whether an interface program is a protectable "expression" or an unprotectable "idea" away from the user to the proprietor.

The group of smaller vendors bitterly opposes changes in this proposal, arguing it would impede the development of open systems interchange and the growth of a now vibrant European systems integration industry. They claim it would put the majority of European industry, dependent on interface information, at the mercy of a few dominant U.S. vendors.

These second-tier software companies have formed a group called the European Committee for Interoperable Systems (ECIS) to coordinate their lobbying efforts. Lobbying on behalf of the big producers are the Computer and Business Equipment Manufacturers Association, the Business Software Association (BSA), the Software Publishers Association and the recently formed Software Action Group for Europe. These associations represent companies that supply 70% of the world software market, including such European companies as N.V. Philips' GL and Siemens AG.

ECIS members have been lobbying

to include an amendment to the EC draft proposal that would allow research and analysis of computer programs without authorization and, possibly, licensing fees from copyright owners.

The directive currently proposes restricting "loading, viewing, running or storing" a program to the program's proprietor and license holders. The ECIS wants to permit reverse analysis without requiring authorization or licensing by the proprietor. The directive makes no mention of licensing fees. It says merely that the proprietor has exclusive rights to distribute its program by sales, licensing, lease and rental.

"Everyone does reverse engineering, not to copy programs, but to survive," says Philippe Wacker, a Brussels lobbyist representing ECIS. He explains that companies analyze software to develop interoperable and new products. Specifically restricting reverse analysis, he says, would reinforce the dominant position of the major software makers and impede the growth of small and medium-sized suppliers.

Opponents contend that the ECIS proposal would facilitate software piracy in the EC, saying it would spur the kind of sophisticated software theft in which companies steal the good parts of a program, sometimes even modifying its language, to launch their own products. "It would be more difficult to prosecute [such] pirates," says Bradford Smith, the BSA's European legal adviser, because reverse engineering, one of the most important elements in proving wrongdoing, would become legal.

In the United States, according to the BSA, software piracy costs industry more than $4.1 billion a year in lost revenue.

The intense maneuvering between the two groups reflects the high stakes involved. In 1988, the European packaged software market was valued at $16.1 billion, according to market researcher International Data Corp. UK Ltd. This market is expected to grow at an average annual rate of 23% this year and in 1991 to reach $30 billion. IBM notes that the percentage of software revenue out of total computer industry revenue is expected to rise to more than 50% by 1995 from its current level of 30% to 40%.

EC officials reponsible for the directive have been torn between their concern with establishing legal standards that will help combat software piracy and their desire to foster the development of open systems and competition. Early readings of the outcome of the directive indicate that the two sides have squared off in such a way that neither the existing international copyright principles for computer programs nor the current balance of market power is threatened. Still, unexpected political pressure from any one of the EC's three governing bodies could tip the balance one way or the other.

The directive, whatever the outcome, will make it "more difficult to operate illegally [in the European Community]," says an EC official. □

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Who rules the low-end page printer market? HP

Hewlett-Packard's new low-performance, low-price nonimpact printers have created a whole new bottom-of-the-line market. But how long can HP stay king of the molehill?

BY JOHN McCREADIE

In low-end page printer territory — which includes nonimpact ink jet, laser and laserlike technologies — Hewlett-Packard Co. is king. Having gotten a jump on that market a few years back with its 8-page-per-minute (ppm) Laserjet product, the large Palo Alto, Calif.-based computer maker continues to beat out its competition by taking the industry to new lows — a little lower performance for a much lower price.

The implication of HP's astounding success with its Laserjet printers is clear: Laser printer vendors building low-end machines will face a tough market this year as they try to shake HP's tight hold on the nonimpact printer market, 90% of which is laser printer technology.

Industry analysts report HP's current share of the $4 billion low-end printer segment — 10-ppm and slower printers — at a whopping 65%, making it an undisputed leader in that arena. Apple Computer Inc. in Cupertino, Calif., is the nearest competitor with a 13% share, followed by a host of 25 or so page printer vendors, including Panasonic Industrial Co., QMS Inc. and Qume Corp., all vying for the remaining 22% of this fast-growth segment.

As competition heats up, HP's biggest competitor may come from out of the blue. IBM recently rolled out a 10-ppm laser printer from its Lexington, Ky., plant and is marketing it aggressively, campaigning that the product is "made in America." With a list price of $2,595, IBM's machine offers higher performance and more features than HP's original Laserjet, but lists for $100 less.

Another contender not yet in the low-end portion of the market is Xerox Corp. based in Stamford, Conn., which makes predominantly high-end page printers. But analysts speculate that the company may not be far from introducing a competitive low-end product. With Xerox's extensive sales force, analysts say, the company would be in a good position to steal away market share — which is bad news particularly for smaller printer manufacturers.

But HP has no plans to let up on its market dominance in 1990. "That market at the low end is huge, and we haven't even begun to tap it," says Phillip Hayes, HP's product marketing manager for its peripherals group based in San Diego. Its newly introduced Laserjet Series IIp has a performance output of 4 ppm and a $995 street price. HP has high hopes for this gem in a market it estimates will be worth about $2 billion in worldwide sales this year.

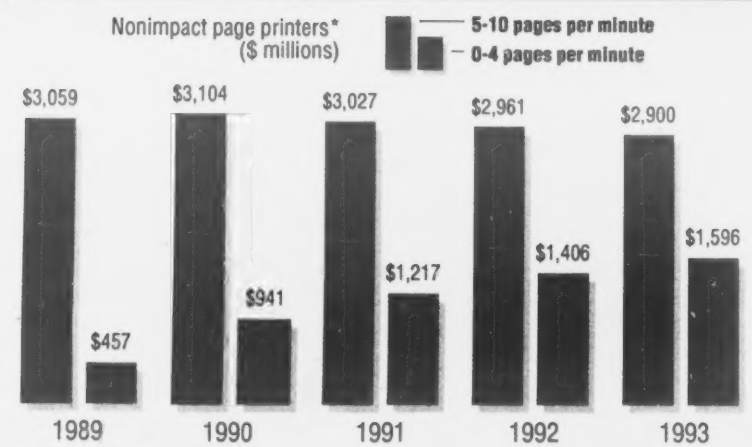
Low price, high growth

The low end market segment does look attractive. At the 4-ppm level — a segment HP recently created — the quiet, typeset quality printers are estimated to have a yearly compounded growth rate of 60%, making it the hottest growth segment in the printer industry, according to BIS CAP International, a Norwell, Mass.-based market research firm. The 1990 value of the market will be $941 million, rising to $1.6 billion with shipments at 1.8 million units in 1993, BIS CAP analysts estimate.

This should take the steam out of the 5-ppm to 10-ppm printer segment. By 1993, 1.3 million units in this range will be shipped, accounting for revenue of $2.9 billion, down from 1990 revenue of $3.1 billion, BIS CAP projects.

Certainly the low-end page printer market is not for the fainthearted. As prices continue to fall, company profit margins will be squeezed, analysts and industry execs agree. Still, this isn't necessarily bad news for those companies that can increase their market share and reap the addi-

Slower page printers show faster growth



* Includes ink jet, laser and laserlike technologies

Source: BIS CAP International

tional rewards of selling consumable products such as toner and font cartridges. Analysts also expect the fierce competition to shake a few players out in the coming year or two.

"It's a matter of the rich getting richer," observes Rob Auster, printer analyst for BIS CAP International. "There's not enough business to go around for everybody."

The success of low-cost page printers will put pressure on other areas of the printer industry as well, notably the high end of the impact printer market. Impact printers have long been on a declining growth trend as more users opt for the quality and quiet of nonimpact printers.

However, as competition for the nonimpact market picks up, future design choices become increasingly more difficult to make. "It's not clear what performance level will become the industry standard [with low-end printers]," notes Dave Krevanko, vice president of printer product marketing for Fujitsu America Inc. Many manufacturers are uncertain what performance level — from 4 ppm to 10 ppm — the market will settle on at the less than $1,000 street price. This makes future design decisions a risky business, indeed.

Leapfrog strategy

Last year, as competitors were positioning products to compete with HP's successful 8-ppm printer, HP simply changed the rules and redefined the low-end laser printer market. Outpacing the growing number of printer vendors entering the nonimpact market, HP introduced its 4-ppm laser printer in September, bringing high-quality print technology within the price grasp of personal computer users at a discount sales price of less than $1,000 — the price threshold long sought after by page printer vendors.

Fewer components and a simplified design gave the company the manufacturing edge it needed to enter the market at the low $1,495 list price, which many dealers instantly converted to a $995 street price, according to HP's Hayes. "When you come in at that price level, you know you can count on the volumes to follow," he says.

Low-cost printer engines supplied by Canon USA Inc. based in Lake Success, N.Y., also served to bring down the price of the HP laser printer, analyst Auster adds. "Canon made a devil's deal with Hewlett-Packard [to supply it with low-cost printer engineers]," he says. That deal certainly has paid off for both companies as volumes have mounted.

The net result has put other page printer manufacturers in the disheartening position of having to aggressively reduce low-end nonimpact prices. Epson America Inc. based in Torrance, Calif., for example, originally introduced its 6-ppm laser printer at $1,899 and has since reduced the list price to $1,495.

Such sudden and harsh price battles have put a profit margin strain on page printer vendors, observers say. But in a market such as this, profit margin may not be a manufacturer's primary concern.

Smaller companies will find it increasingly more difficult to compete effectively

"In 1990 most printer manufacturers will be focused on market share, not margins," says Ed Pullen, printer industry analyst for the market research firm InfoCorp. Creating a strong installed base is important because "after you establish a marketplace, you can make healthy margins on consumables," he says. Analyst Auster puts it another way: "Give them the razor, and sell them the blades."

Growing competition

The competition in the page printer market will spill over into surrounding printer segments, analysts say. The 24-pin impact printer, whose pricing and performance levels are at the high end of the impact printer market, will be the most vulnerable, Auster notes. Even HP runs the risk of cannibalizing its own laser and ink jet products as consumers weigh performance, print quality and price with the new Laserjet Series IIp.

But HP is aware of such risks. "We'd rather cannibalize them ourselves than have our competitors do it for us," Hayes says. Adds Auster of BIS CAP, "I wouldn't be surprised to see HP lower its ink jet prices to put more pricing distance between its ink jet and laser printers."

As bigger companies are lured into the low end of the market by the potential for high-volume sales, the smaller companies will find it increasingly more difficult to compete effectively. Michael Sugihara, vice president of printer products for the Milpitas, Calif.-based Qume, hopes IBM's entrance into the low-end page printer market will distract HP long enough for him to secure a market hold for his 6-ppm printer. "I'm hoping they will sort of duke it out and wear each other down," he says.

Many manufacturers are hoping to cut into HP's market lead by offering a price competitive, higher performance machine equipped with more features such as adjustable paper trays. But while other printer manufacturers sink their R&D dollars into beating out the Laserjet products, Auster notes, HP is quietly sinking its R&D revenue into its ace in the hole: ink jet technology. Although HP is already a leader in the ink jet market, new successes in performance and print quality would greatly enhance the market's viability.

Meanwhile, page printer manufacturing executives will have to determine which performance levels the market will embrace for the long term — a critical decision for competing in this marketplace. The quick shift the market has taken in recent months has left some manufacturers confused about the correct direction to take in future product design.

"There's a lot of instability in [companies'] strategic directions right now," notes George Alexy, vice president of marketing for Cirrus Logic Inc. of Milpitas, Calif., a supplier of coprocessor and accelerator chips that is working closely with several major printer OEMs. "I've seen a couple of situations where a product plan has been revised three times in the last year."

Even though HP may have been first to dip below the $1,500 mark, other manufacturers' offerings could still become the printers of choice for personal computers if they can get the prices of their 6 ppm and 8 ppm machines down to a comparable level. For now, with HP still dominating the market, vendors are paying careful attention to what the page printer king does next. □

Artificial intelligence finds work in manufacturing

Expert system vendors are coming down out of the clouds onto the factory floor and finding big business with America's manufacturing industries

BY PETER BURROWS

After years of trying, expert systems suppliers are finally finding their way into the hearts and budgets of a wide variety of manufacturers. As the hype surrounding these artificial intelligence-based decision-making aids subsides, competitors are scrambling to provide solutions to nuts and bolts production problems — and manufacturers are discovering thousands of applications.

Expert systems, which are basically repositories of human expertise bundled with software that makes decisions based on a given set of rules, are tailor made for manufacturing, observers say. With tremendous interpolations of data and interacting processes to worry about, factory floor personnel are benefiting from programs that take on routine decision-making duties. For example, a diagnosis program can help maintenance managers catch potential breakdowns before they happen and suggest repairs when they do.

"There is a quiet revolution going on," says Bob Moore, president of Gensym Corp., a Cambridge, Mass., vendor of a process control system called G2. "In the old days you had people sitting in their stations on the floor, watching over what was going on. Now with automation, they sit in huge control rooms with thousands of measurements to worry about. No human can do that efficiently, but expert systems can."

Manufacturing is now the fastest growing segment of the $130 million market for expert systems. In 1986 it accounted for less than 3% of all AI-based hardware and software sales, says Harvey Newquist, publisher of the newsletter *AI Trends* based in Scottsdale, Ariz. By 1989, that percentage had grown to 20%, and he expects it to stabilize around 25% by the early '90s.

"In the next few years some of the vendors will experience a 100% growth rate," predicts Les Hellenack, director of new software technologies with market researcher International Data Corp. in Framingham, Mass. "The market itself may very well see growth in the 40% to 50% range for a few years and then level off."

Hardware and software sales represent only part of the picture. Users will spend $650 million a year by 1992 on products and related consulting, integration, delivery and personnel services — up from $350 million in 1989, says Susan Eppenheimer, editor of *Artificial Intelligence Manufacturing* newsletter based in Natick, Mass.

A counterrevolution

Ironically, this revolution — if successful — will be the result of counterrevolutionary strategies, reversing the ultra-high-tech approach of the first AI developers. "In the early days there was too much emphasis on expert systems as opposed to knowledge-based systems," says Larry Harris, chairman of AI Corp., a pioneering AI company based in Waltham, Mass. "We were trying to bite off the very top level of human performance. Now we're finding that companies have a need in the more traditional applications."

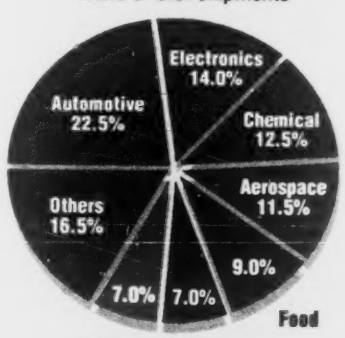
Industry pioneers focused on generic software development tools that customers in diverse industries could use to program solutions themselves. Most ran on dedicated, standalone mainframes based on the hard-to-use list processing (LISP) programming language. Not only did the hardware alone often cost $100,000, but a vendor-supplied "knowledge engineer" was invariably required to get the system up and running.

Because these ambitious programs were so expensive and complex, the principal users tended to be those making specialized, esoteric products with high price tags themselves, such as defense and aerospace equipment, or high-volume operations, such as automakers. "It was not the stuff someone in an MIS [management information system] department could relate to," Eppenheimer says, "and these vendors were asking you to redo your entire operation to implement their technology."

But vendors are now focusing on more bread-and-butter manufacturing needs. At the same time, technologies have converged to make expert systems easier to use, easier to integrate with conventional hardware and easier on the budget. As a result, the number of applications will continue to balloon, observers say. E.I. du Pont de Nemours and Co. alone has around 1,000 applications, according to David Schnelle, a senior

Off-the-shelf expert systems market segments

Share of U.S. shipments



Total 1989 market: $24 million

Source: Automation Research Corp.

consulting engineer with the Wilmington, Del.,-based pharmaceutical giant.

No dominant players have emerged, but the rising awareness of expert systems' benefits is turning many AI vendors profitable. Older companies, often under the leadership of businesspeople brought in to replace academic company founders, have been refocused to meet customers needs, rather than technology's.

Carnegie Group Inc. of Pittsburgh, one of the Gang of Four that has dominated the AI industry, for example, has revitalized itself by offering a range of products geared specifically to the manufacturing and telecommunications segments. Another Gang of Four member, IntelliCorp of Mountain View, Calif., rebounded from flat revenues and sales in 1987 and 1988 last year by simplifying some of its high-end software development tools and offering more industry-specific applications.

The formula for success

A new generation of start-ups, born with the prevailing pragmatic view of AI in mind, is also enjoying success. Foremost among these is Gensym. Founded in 1986, the company was market leader by 1988 with an 18.2% share, according to Automation Research Corp., and was profitable in all six quarters that it shipped product. The company expects 100% growth with $10 million in sales this year over $5 million last year.

Gensym's G2 system has many of the hallmarks of a commercially successful expert system. Natural language capabilities allow nonprogrammers to develop applications using English commands or a mouse — without the help of a knowledge engineer. It has real-time capabilities, allowing it to update managers of factory conditions immediately and to monitor multiple processes at once. It can be networked with databases and automation equipment, enabling it to oversee the production process. And it is a classic example of a "vertically oriented application."

This term refers to products that are customized to meet the needs of a particular industry. It encompasses two classes of products: preprogrammed off-the-shelf applications that can tackle a specific task with a minimum of customization, such as

New-breed CEO turns pipe dreams into products

Dennis Yablonsky of Carnegie Group Inc. represents a new breed of CEO in artificial intelligence. Brought in by the company's academic founders in 1987, he is on the way to turning pipe dreams into products and sales pitches into contracts.

The company, founded in 1984, has never lacked for funds. Digital Equipment Corp., Boeing Co., Ford Motor Co., Texas Instruments Inc. and US West Inc. have all contributed 10% stakes at one time or another. "Venture capital flowed into this business between 1983 and 1986 like a broken spigot," says Harvey Newquist, publisher of the newsletter *AI Trends* based in Scottsdale, Ariz.

"Yablonsky wasn't brought in to just raise venture capital," he adds. Unlike his AI predecessors, Yablonsky's background is in software development. Now 37, he has spent most of his career as president and chief operating officer for Cincom Systems Inc. in Cincinnati, and observers say he brings a much needed conservatism to an industry historically awash with great expectations.

"A lot of egos had to be shot out of the sky," Newquist says. "You had academics who thought AI was the most important business in the world. But Yablonsky just wants a nice even growth rate."

Carnegie Group, based in Pittsburgh, has yet to have a profitable year, analysts report, but it has made the transition to a solution-oriented company. It has carved its niche in the manufacturing and telecommunications sectors and has expanded its product development focus to include integration and maintenance services. With its close links to the highly regarded AI program at Carnegie-Mellon University, the company is on the vanguard of making expert systems more effective and readily available to non-AI programmers.

Dennis Yablonsky of the Carnegie Group: "The expectations for expert systems in the past were fine. The timeframe was wrong"

Shared enthusiasm

Yablonsky's tactics may set him apart from some of his forerunners, but he shares their enthusiasm for the promise of AI. "The expectations for expert systems in the past were fine," he says. "The timeframe was wrong. It wasn't that what was accomplished wasn't valuable. It's just that it didn't live up to expectations."

He thinks it will be different in the 1990s. "Most of the traditional business applications were automated in the 1970s," Yablonsky says, "but expert systems technology represents a breakthrough that will enable companies to automate that which they hadn't been able to before" — namely, decision making. He foresees the $500 million market in expert systems products and services in 1988 growing well beyond $1 billion in the next decade.

"The biggest challenge is the continuation of the credibility problem," Yablonsky says. "We have to show the actual benefits of what we can do." □

diagnostics or smart computer-aided design; and application shells, which are empty expert systems that can handle a range of industry-specific functions once programmed with the necessary knowledge base. Customers give up the flexibility of generic development tools, but get products more suited to their needs.

And vendors get an easier sell. "A lot of companies are verticalizing their marketing departments, rather than trying to sell the same story to everyone," says Alan Sherwood, AI segment manager of Sun Microsystems Inc. in Mountain View, Calif. "It is much easier to sell discrete manufacturing applications to automobile manufacturers and process control applications to chemical companies."

The off-the-shelf category is the fastest growing of the market. Averaging $23,000 each, these programs combine the affordability and ease that appeals to manufacturers in need of low-maintenance solutions to clearly defined problems. Dan Cretus, an analyst with Automation Research Corp. in Medfield, Mass., estimated 1,000 of these products worth $24 million were in use by the end of 1989, and 3,000 products worth $75 million will be in use by 1994.

Action in application shells

While off-the-shelf applications are scoring big in unit sales, "the action in terms of dollar value is in application shells," says Tom Schwartz, a consultant from Mountain View, Calif. "If you make one of these [shells] aimed at something that's expensive to do, you can charge a lot of money for it." A multibillion dollar oil company, for example, can easily pay for a process control program with a six-digit price tag if it can achieve a 2% or 3% reduction in operating costs, he points out. AI Corp., Carnegie Group, Digital Equipment Corp., Inference Corp. and Aion Corp. have all introduced application shells.

Impressive returns on investment in expert systems are increasingly common, but almost exclusively for *Fortune* 100 companies. DEC, for example, has saved at least $150 million a year by using expert systems, says Scott Flaig, a partner with Ernst & Young who headed DEC's AI program in 1987-88. Du Pont has regularly realized an ROI of 10-to-1 with its process control applications and up to 50-to-1 for advisory and scheduling aids, du Pont's Schnelle says.

"Few large industrial companies have not implemented some sort of expert system," Eppenheimer says. But expert systems are only beginning their assault on the rest of the manufacturing world. Of 350 companies surveyed by Ernst & Young at the Autofact trade show in 1988, only 4% had any AI-based products, and 55% had no plans to implement any.

"Most small companies still can't afford it," says Tom Laffey, vice president of engineering for Talarian Corp., a recent Silicon Valley startup. "Most want to see other instances of million dollar savings from expert systems."

Impressive returns on investment in expert systems are increasingly common

Still, market observers say smaller companies will buy — and probably sooner than they think. As user-friendly environments, with natural language commands and graphical interfaces, are cutting knowledge engineers out of the process, implementation times have been cut from months to hours. "There's a whole huge wave of people who are going to buy these products once they become very easy to use," Eppenheimer predicts.

More than half the expert systems sold last year resided on workstations — which have undergone rapid price point and performance improvements, Eppenheimer says. Yet less expensive PC-based applications are proliferating as well. One such product is Operations Planner, a factory process-control simulation tool from Carnegie Group. When it was introduced by now-defunct Palladian Software Inc. in 1986, it cost $100,000 and ran on a $50,000 LISP machine. Now it sells for $4,000, runs on a PC and has an easy Macintosh-like environment. "Basically you fill in the blanks," product manager Joe Coletti says. "What you have to know about is manufacturing."

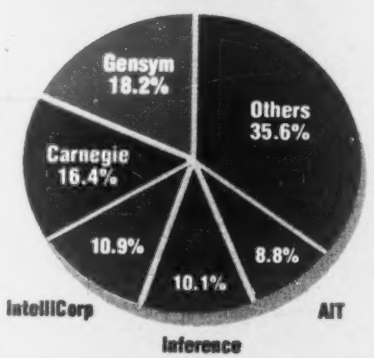
But the critical element in the assault on the manufacturing world is customer awareness of the products' utility, observers agree. As AI sheds its image as a cryptic and costly research experiment, competing vendors are struggling to quantify the benefits of their products, many of which do not show up in conventional definitions of ROI. Often, expert systems reduce hidden costs, such as equipment downtime, or improve nonfinancial factors, such as quality. "What's the cost of running out of a 26 cent part that prevents you from shipping a $2 million machine?" consultant Schwartz says. "Not only can't you show the product as a billing, but you have to shut down the line, and you've upset your customer."

Even hardware vendors are taking notice of expert systems' rising popularity. For example, when reports from salespeople showed that 6% of their hardware is used to run expert systems, Sun Microsystems put together an AI group to configure workstations for these programs.

With this kind of help, expert systems will soon become no more extraordinary than spreadsheets and databases, Sun's Sherwood says. At that point, they will be an accepted cost of doing business. "Five or 10 years ago a Mac interface was considered AI," he says. "Now it's just a Mac interface. In some cases these products are simply getting so useful and friendly that they're not that strange anymore." □

Leaders in off-the-shelf expert systems

Share of U.S. shipments



Total 1989 market: $24 million

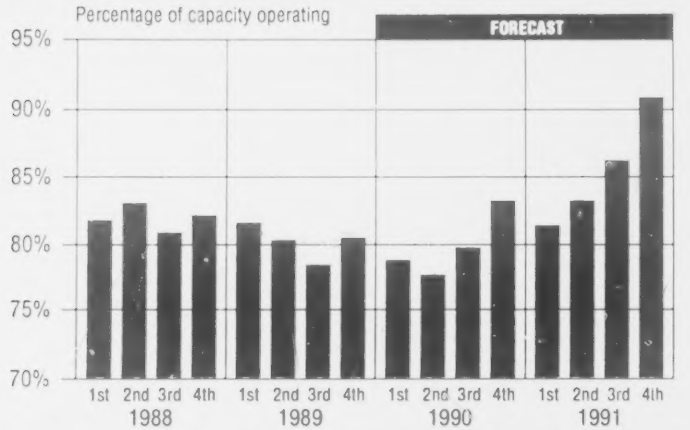
Source: Automation Research Corp.

Leadtimes in detail

Average delivery time in weeks	4th qtr. 1987	4th qtr. 1988	4th qtr. 1989	FORECAST 4th qtr. 1990
Discrete semiconductors	7.9	6.2	6.2	6.0
Integrated circuits	7.2	5.8	5.4	5.2
Memory circuits	9.0	11.4	8.1	7.4
Microprocessors	8.8	8.5	7.5	7.4
Displays	8.6	8.0	7.5	6.5
Capacitors	6.7	6.1	5.3	6.5
Connectors	6.6	5.7	4.3	5.3
Printed circuit boards	6.1	5.4	5.1	4.9
Relays	7.7	6.7	6.3	6.6
Resistors	4.9	4.6	4.2	4.5
Switches	6.0	6.2	5.0	5.7
Wire and cable	4.3	3.8	3.6	3.1

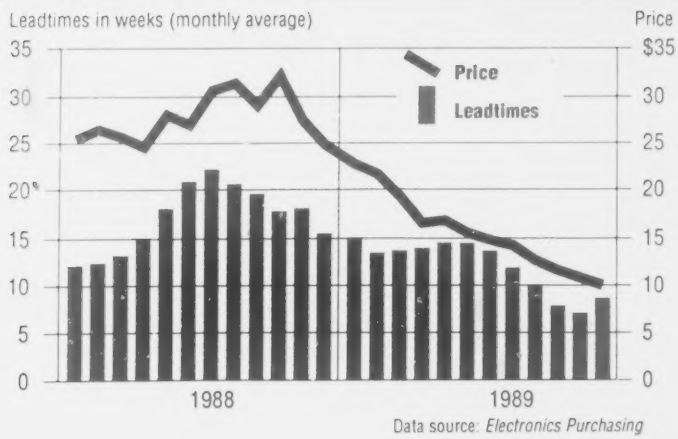
Data source: *Electronics Purchasing*; Forecast: Cahners Economics

Electronic manufacturing operating rate



Data source: *Electronics Purchasing*; Forecast: Cahners Economics

1Mb DRAM prices and leadtimes



Data source: *Electronics Purchasing*

Leadtimes hint at stable prices in 1990

In the latest purchaser survey completed by ELECTRONICS BUSINESS' sister publication, *Electronics Purchasing*, buyers report that delivery times for most electronic components fell in the final season of last year. Most notably, leadtimes for memory devices sped up by over three weeks, as delivery times fell from an average 11.4 weeks in the fourth quarter of 1988 to just over 8 weeks by the end of 1989. Every other major product category, excluding discrete semiconductors, which held steady at a low 6.2 weeks, saw leadtimes fall from last year's levels.

In fact, leadtimes have been shrinking for most components throughout much of 1989. That's just another precursor to the slowdown in electronic equipment shipments and semiconductor sales that has been taking place this past year. This year, Cahners Economics expects composite leadtimes for all electronic components to fall to 5.8 weeks, down from 7 weeks in 1989 and 7.4 weeks in 1988.

Faster delivery times reflect weaker demand from buyers as they remain cautious about sales prospects in 1990. As a result of that caution, 46% of the buyers surveyed in December 1989 report that they are still reducing inventory and only 23% are building stocks. Still, the December inventory strategy of buyers has shown some improvements: From May through July 1989, fewer than 5% of those surveyed indicated they were restocking.

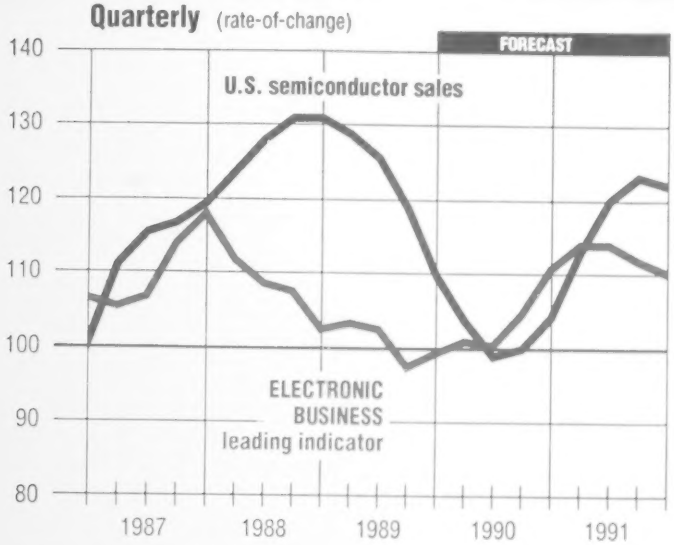
Leadtimes for particular components give some warning of the probable direction of tomorrow's prices. For example, leadtimes for 1-megabit dynamic random access memory chips (1Mb DRAM) peaked at 21.6 weeks in July of 1988. Prices for these devices, based on average transaction prices reported by buyers, peaked at $31.80 in October 1988, three months after the leadtimes had peaked.

Now, leadtimes for 1Mb DRAMs have fallen rapidly, to a low of 6.8 weeks last November. In tandem, prices have also fallen dramatically, down to $9.70 in December 1989, a 69% decline from the peak price set in 1988.

In 1990, leadtimes should continue to shrink, but not by much. For most components, pricing will remain relatively stable as well.

ELIZABETH B. BAATZ

ELECTRONIC BUSINESS leading indicator



SPECIAL OFFER: A detailed 12-page background paper is available on the ELECTRONIC BUSINESS leading indicator. To obtain your complimentary copy, please contact Elizabeth Baatz at Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158-1630 USA, telephone (617) 558-4368, fax (617) 558-4402

In 1990, we expect growth in the electronics industry will be stronger than most forecasters have been predicting. The ELECTRONIC BUSINESS leading indicator stood at 99.7 in November, up from a revised 97.3 in October. Last month we forecasted the indicator would hit bottom in December at 95.0. Now, monthly data in for November and December are pushing our estimates back up. The turning point may indeed have been passed in September of 1989.

Source: Cahners Economics

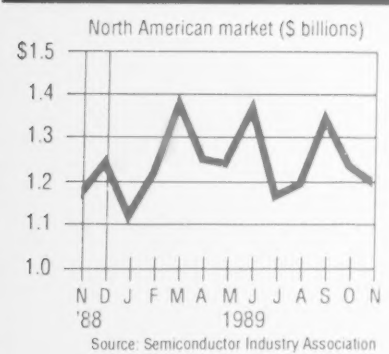
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Oct.)	99.7	97.3	102.7	107.7
U.S. semiconductor bookings ($ millions, 3-month average, Nov.)	$1,172	$1,194	$1,147	$1,178
Weekly hours of semiconductor production workers (monthly average, Oct.)	40.7	40.5	39.9	40.2
Electronic components leadtime index (1977 = 100, Dec.)	89.9	94.2	89.7	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, Nov.)	57.1	58.7	44.2	54.4
Change in electronic components inventories ($ millions, SA, Oct.)	-$53	-$126	+$101	+$80
Contracts and orders for plant and equipment ($ billions, SA, Oct.)	$41.5	$40.7	$38.6	$39.7

SA = seasonally adjusted, all other data is not seasonally adjusted

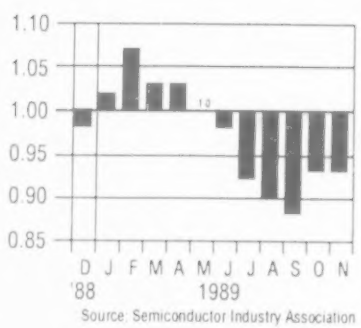
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Source: U.S. Commerce Department